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Agricultural Memorandum No 765

Gastro-Intestinal Nematode Infection in Sheep & Cattle

by J. R. STARR

Introduction.

The life history of the nematode parasites of domestic ruminants usually involves development and survival of free-living stages on pasture, since these animals are still largely managed in grazing systems. In the typical cycle the nematode eggs are passed in the faeces of the host where they hatch and develop through three successive larval stages, the first two being relatively inactive feeding forms. The third or infective stage is a more active larva and migrates onto the herbage to be taken up by the grazing host. The pasture is therefore the site of deposition, development and transmission of nematode infection, and meteorological factors affecting the pasture will affect the parasite.

The complexity of the role of the pasture in the host-parasite relationship means that the results of laboratory experiments cannot be directly related to field conditions and it is essential that an understanding of the influence of climate on the free-living stages should be investigated 'in situ'.

Ostertagia and Trichostrongylus Infection

There are a number of different parasites involved in gastro-intestinal nematode infection in sheep and cattle, but in practice the worm burden is dominated in Britain by the Ostertagia and Trichostrongylus species, the former being particularly numerous in lambs until at least mid-summer.

The simplest epidemiological situation is that in which ewes and lambs are turned out in spring onto clean pasture and it is this situation which has been examined by Boag and Thomas (1971). The sole source of nematode infection for lambs is the post parturient rise in egg output of the ewes, the bulk of the infective larvae appearing on the pasture ten to twelve weeks after egg deposition starts (Fig. 1).

Wetness Units and Peak Larval Count

The possibility of detecting a correlation between the pattern of larval counts and meteorological factors was tested by L. P. Smith using the data of Boag and Thomas from a series of experiments at Cockle Park, Northumberland. Ewes and lambs, with similar lambing dates each year, were stocked on one-acre plots at the same stocking density and under the same general management conditions. The pasture was stocked each year on about 15 April and the timing of the steep rise to peak larval count varied from early July to mid-August over a five year period from 1967.

Using standard meteorological records from Acklington, and commencing from 15 April, L. P. Smith tested the assumption that temperature and moisture were dominant factors influencing the variation of peak count date, and developed a subjective 'wetness unit' approach. (Ag. Mem. 425, 546 and discussed by Thomas 1974). Essentially the 'wetness units' were a measure of the daily duration of surface moisture (no correlation with temperature was found).

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The consistency of the relationship between Smith's predictions and the pasture larval counts encourage further work on this correlation. In particular, to be of operational use, an objective method of assessing the duration of surface wetness following any given rainfall must be developed.

Predicting the Course of Nematode Larval Infection on Pasture.

As a starting point it is sensible to devise an assessment technique which reproduces closely the daily allocation of 'wetness units' achieved by Smith. Many 'scoring' techniques were tried but the basic logic was the same - 12-hourly rainfall data from Acklington and Tynemouth were tabulated in the form: Night Rain (2100-0900) | Day Rain (0900-2100) the date being that of the 'Day' period. Each half-day period, P, was then allocated a 'wet score, Wp,' which depended not only on the quantity of rain that fell during the period but also on the 'rain history' of the preceding periods and whether P was 'night' or 'day'. Thus a wet period with slight rain preceded by a dry sequence might score less than a dry period preceded by a very wet sequence.

The allocation method finally decided upon is illustrated in Fig. 2.; it can be quickly mastered (see also Appendix). It is seen that Wp is in the range 0 to 3 depending basically upon certain rainfall limits as well as 'history'. The decision as to what these 'limits' should be was based on educated guesswork and an eye to the forms of rainfall data that might be used by the Agriculturalist. Thus presentation of data in the Daily Weather Report (DWR) is such that rainfall from 0 to 0.6 mm is as recorded, 0.7 to 0.9 mm are reported as 1 mm and above that rainfall is reported to the nearest 1 mm, half mm values being 'thrown' to the odd integer (e.g., 2.5 mm and 3.5 mm both are reported as 3 mm). Accordingly rainfall limits must be chosen to be consistent with DWR data as the following example illustrates:

A sequence of rainfall (mm) over 4 days might be recorded follows:

2100-0900	0900-2100
0	0
0.8	0.2
0	4.7
0	0.7

appearing in the DWR as

2100-0900	0900-2100
0	0
1	0.2
0	5
0	1

Using the rainfall limits defined in Fig. 2 the 'wet score' in both cases is allocated:

21 - 09	09 - 21
0	0
1	1
0	3
1	2

If the relevant limits had been chosen as 1 and 5 instead of 0.7 and 4.5 the allocation would become

21 - 09	09 - 21
0	0
0	0
0	1
0	0

Since both forms of rainfall records are available the system must be used which makes sense both intuitively and practically!

A Refinement

The extent to which a pasture will remain moist will depend on a number of factors but it seems reasonable to 'weight' the wet score by a factor which depends on the daily sunshine. A suitable factor, S, was found to be:

Sunshine hours	S
$\geq$ 8	4
4 to 7.9	5
$<$ 4	6

Thus an overcast wet day is considered to be $1\frac{1}{2}$ times more effective than a very sunny day with the same rainfall, in encouraging nematode development.

Each day thus has an associated total 'wet score W' and sunshine factor 'S' the product WxS is a daily measure of surface wetness which can vary from zero to 36 units (i.e., (3+3)x6).

Correlation with Field Experiments

The Cockle Park fortnightly sampling method necessarily implies that a precise peak count date cannot be defined. However any predictive technique should probably give a date to within $\pm$ 5 to 10 days of the quoted experimental peak date. A further limitation to the accuracy will be imposed by the proximity and representivity of rainfall measurements to the experimental site (In this study Acklington is 10 km to N and Tynemouth 25 km to SE of Cockle Park).

A cursory examination of the monthly rainfall totals suggests that there is a difference in the efficacy of early and late rainfall in encouraging larval development, comparatively large April and May rainfall not necessarily leading to early peak counts. Weight is given to this impression on inspecting Fig. 1; the eggs are deposited onto the pasture by the ewe over a 6 week period but the subsequent infective stage reaches a sharp peak over perhaps 2 weeks. This 'concertina effect' remarked on by Thomas 1974, is found to be consistent with a reduction of the contribution of the 16 April - 31 May 'W_xS' product by 40%.

Correlation between dates of peak larval count and cumulative 'WS' units for the nine years 1967-75 is shown in Tables 1 and 2. The peak count data are based on a 'Critical Index' of 440 units, and in all cases lie within the estimated experimental error.

In view of the simplistic nature of the allocation model, the inherent errors in the experimental data and the possible non-representativeness of the rainfall measurements, the results can be regarded as most satisfactory.

A 'Warning Index'.

Of more value to an Agriculturalist than a 'Critical Index' will be a 'Warning Index' which anticipates the potential contamination of the pasture. Warning dates based on indices of 380 and 350 are presented in Tables 1 and 2. The nature of the warning index must be fully appreciated; the warning it gives is clearly a function of subsequent rainfall. In tables1 and 2 the

the warning supplied by an index of 380 varies from 2 days to over 20; for an index of 350 : 3 days to over 30. Attainment of the chosen 'Warning Index' will, then, necessitate the stipulation that potential contamination is likely after a further, say 60 or 90 WS units - the peak larval count can only be anticipated in terms of rain days. Subsequently two or three days of heavy rain could bring about the Critical Index; at the other extreme a month or more of dry weather might occur.

The suggestion is that any operational use of a 'Warning Index' would require close liaison with a local meteorological office, advice being sought on the likely intensity and duration of rain, as soon as the 'Warning index" is attained. It should then be possible to estimate the approach of pasture contamination and take appropriate action.

References.

Boag, B. and Thomas R. J. (1971) Epidemiological Studies on gastro intestinal nematode parasites of sheep.
1. Infection patterns on clean and autumn contaminated pasture. Research in Veterinary Science 12,132-139.

Thomas R. J. (1974) The role of climate in the epidemiology of nematode parasitism in ruminants. Symposia of the British Society for Parasitology Vol.12 p13-32.
Ed A. E. Taylor and R. Muller.

Any comments or suggestions on this paper should be referred to the author.

Meteorological Office
Bracknell

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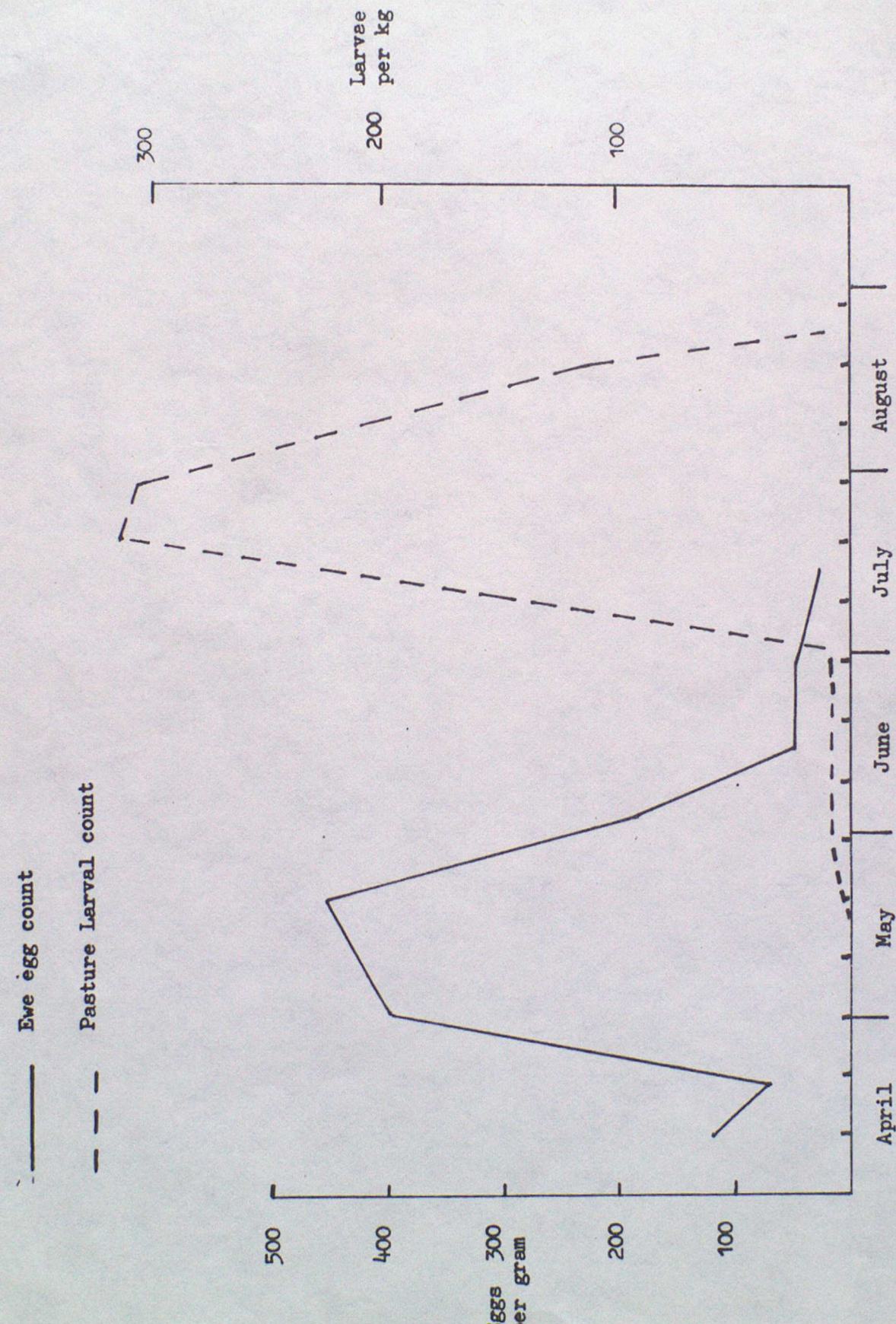
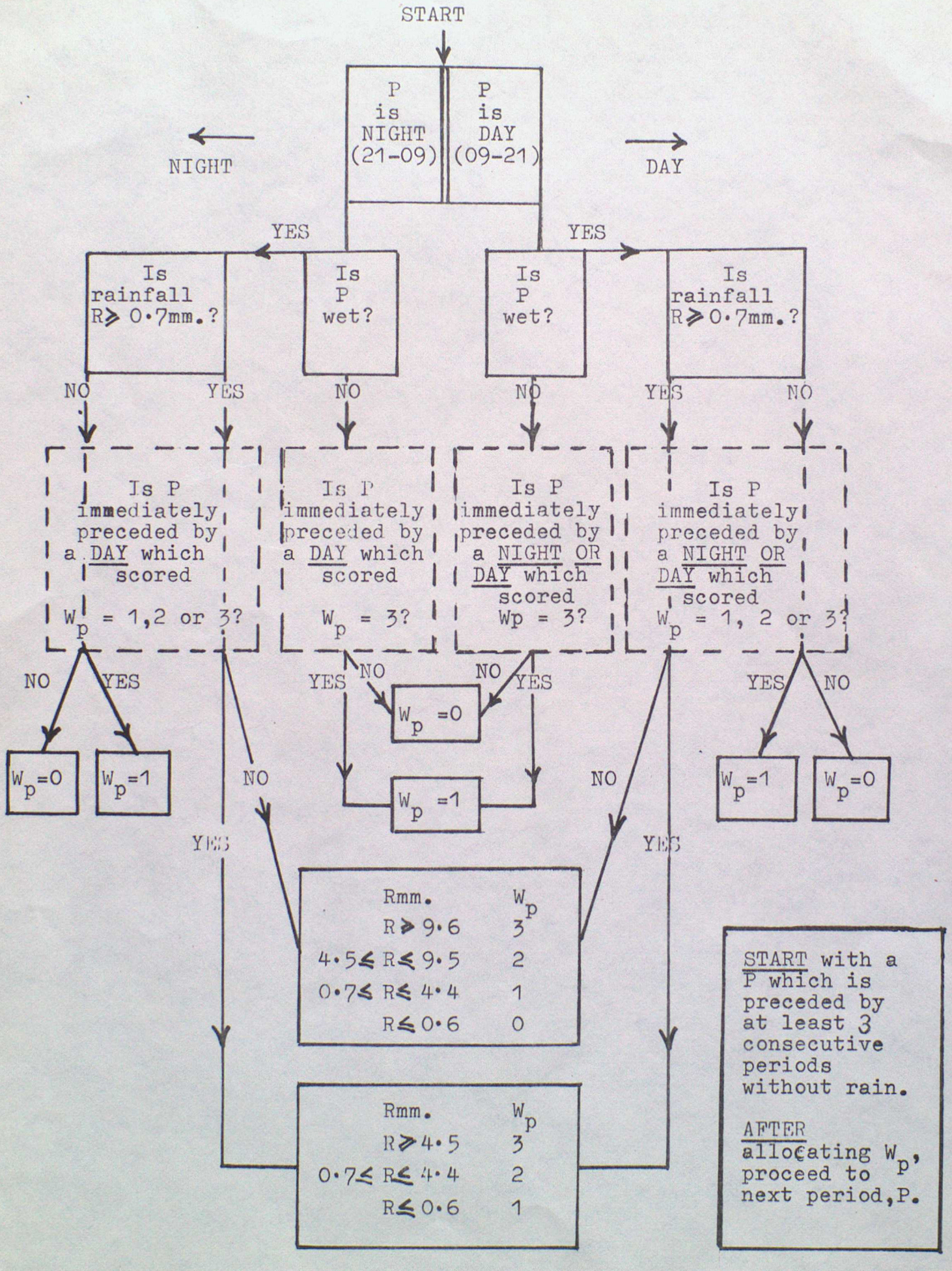
Fig 1

General gastro-intestinal nematode infection: correlation of ewe egg count and pasture larval count



Allocation of 'Wet Score', W_p, to a Half-day Period, P. Fig. 2



APPENDIX

An example of the allocation of 'WS' units to data Acklington:1st-20th May 1969.

Rainfall (mm)			Sunshine		
2100-0900	0900-2100	W	hrs	S	WxS
0	0	0 0	7.2	5	0
0	0.8	0 1	0	6	6
17.8	0	3 1	0	6	24
0	0	0 0	0	6	0
0.2	0	0 0	0	6	0
0.1	11.3	0 3	0	6	18
0	0	1 0	6.3	5	5
3.0	1.8	1 2	0.1	6	18
0.5	0.4	1 1	2.5	6	12
0	2.0	0 2	4.1	5	10
0	2.0	0 2	1.5	6	12
0	0	0 0	8.2	4	0
4.5	0.6	2 1	0	6	18
0	0	0 0	6.7	5	0
0	6.3	0 2	5.2	5	10
2.5	8.3	2 3	0.7	6	30
0.1	0	1 0	7.3	5	5
4.6	0	2 0	12.2	4	8
0.2	0	0 0	5.2	5	0
0	0	0 0	3.1	6	0

Acklington

Nematode Larval Peak Count Date

TABLE 1

Period		1967		1968		1969		1970		1971		1972		1973		1974		1975	
16-30 Ap	x0.6	36		112		125		40		64		24		75		56		84	
-31 May	x0.6	351	232	168	168	219	206	64	62	145	125	232	154	181	154	55	67	173	154
-30 June		135	367	113	281	153	359	105	167	147	272	190	344	93	247	96	163	107	201
-10 July		14	381	75	356	46	405	33	200	14	286	28	372	42	289	75	238	24	285
-15		53	434	48	404	6	411	14	214	0		0		78	367	38	276	32	317
-20		40	474	56	460	0		51	265	18	304	0		52	419	42	318	27	344
-25						5	416	100	365	127	431	54	426	28	447	18	336	44	388
-31						48	464	34	399	36	467	29	455			0		0	
-5 Aug						22		0								58	394	0	
-10								36	425							47	441	0	388
-15								23	448									56	444
-20																			
-25																			

Observed Peak Count date	26 July	16 July	5 Aug	19 Aug	2 Aug	3 Aug	16 July	19 Aug	4-18 Aug
Estimated date on 440 count	17 July	17 July	28 July	14 Aug	26 July	31 July	22 July	14 Aug	15 Aug
'Warning' with 380 counts	8 July	9 July	8 July	28 July	24 July	22 July	17 July	9 Aug	24 July
'Warning' with 350 count	27 June	28 June	24 June	25 July	23 July	3 July	15 July	8 Aug	22 July

First column - Total WS units from previous date

Second column - Cumulative WS Units

Tynemouth

Nematode Larval Peak Count Date

TABLE 2

Period	1967	1968	1969	1970	1971	1972	1973	1974	1975
16–30 April x0.6	58	99	115	66	60	38	64	43	69
–31 May	356 248	133 139	225 204	42 65	109 101	155 116	121 111	25 41	167 142
–30 June	129 377	152 291	139 343	80 145	154 255	146 262	132 243	125 166	93 235
–10 July	8 385	104 395	71 414	9 154	0	34 296	47 290	75 241	36 271
–15	30 415	50 445	0	10 164	0	0	66 356	45 286	64 335
–20	16 431	52	0 414	54 218	0 255	0 296	90 446	28 314	6 341
–25	6 437		4 418	94 312	87 342	54 350		4 318	69 410
–31	48 485		42 460	60 372	66 408	30 380		40 358	0
– 5 Aug			12	0 372	37 445	42 422		0	0
–10				26 398		27 449		52 410	0 410
–15				5 403				42 452	60 470
–20				66 469					
–25									
–31									
Observed Peak Count Date	26 July	16 July	5 Aug	19 Aug	2 Aug	3 Aug	16 July	19 Aug	4–18 Aug.
Estimated Date on 440 count	27 July	14 July	28 July	17 Aug	4 Aug	8 Aug	20 July	12 Aug	13 Aug
Warning with 380 counts	8 July	10 July	8 July	9 Aug	27 July	31 July	17 July	10 Aug	23 July
Warning with 350 count	26 June	8 July	2 July	28 July	26 July	27 July	14 July	29 July	22 July